THE HIGHWAYS AGENCY BA 34/90

THE SCOTTISH OFFICE DEVELOPMENT DEPARTMENT

THE WELSH OFFICE
Y SWYDDFA GYMREIG

THE DEPARTMENT OF THE ENVIRONMENT FOR
NORTHERN IRELAND

Technical Requirements for the Assessment and Strengthening Programme for Highway Structures

Stage 1 - Older Short Span Bridges and Retaining Structures

Summary: This Advice Note complements BD 34/90, the Departmental Standard of the same title and contains advice on its implementaion.

Volume 3 home page

VOLUME 3 HIGHWAY STRUCTURES: INSPECTION AND MAINTENANCE

SECTION 4 ASSESSMENT

PART

BA 34/90

TECHNICAL REQUIREMENTS FOR THE ASSESSMENT AND STRENGTHENING PROGRAMME FOR HIGHWAY STRUCTURES

Contents

Chapter

1. INTRODUCTION

1.1 BD 34/90 sets out the technical requirements for the programme of assessment and strengthening of certain older short span bridges and other structures on motorways and other trunk roads. Following its publication, there have been a number of enquiries from users seeking clarification of various requirements. The purpose of this Advice Note is to make the relevant explanations given to various enquirers generally available to assessing engineers.

1.2 The particular Standards and clauses referred to are given after each heading or sub-heading. In the case of the Bridge Assessment Code, BD 21/84, any reference to the document is as amended by Amendment No 1. It is intended to revise BD 21/84 and BA 16/84 in due course to reflect the guidance given in this Advice Note.

2. ASSESSMENT PROCEDURES

BD 34/90 - Clauses 5 and 6

2.1 For the purposes of assessment, the 'assessing engineer' is the engineer appointed to carry out an assessment by the Department or by a Maintenance Agent acting on its behalf. The Technical Approval Authority (TAA) for the assessment will be as agreed by the appropriate Director (T) of the DTp Regional Office concerned. At present, the TAA would be either the Regional Office itself or DHPSS/Engineering Unit.

2.2 The assessment of the safe load carrying capacity of an existing structure, particularly an older structure, is a complex process which cannot be completely codified and must rely to a great extent upon the judgement and experience of the assessing engineer. It is unlikely that a 'true' estimate of the capacity of a structure can be reached after only a single pass of analysis and calculation. In the majority of cases it will be necessary to carry out several stages of assessment, involving changes of assumptions, changes of structural parameters and different methods of analysis, before there can be any confidence in the estimated value of the capacity of the structure in question.

2.3 If, in the course of an assessment, the assessing engineer considers that the structure is so inadequate for its purpose that there is a potential risk to public safety, he should inform the TAA, through the Department's Agent Authority where appropriate. He should at the same time recommend any immediate action which in his judgement needs to be taken pending the completion of the full assessment procedure.

2.4 In assessing the risk to public safety the engineer should take into account relevant factors such as the nature of the structural weakness and any corresponding signs of distress and the recent loading history of the structure itself. He should also take account of the probabilities of the occurrence of the critical load combinations within the period prior to the implementation of any temporary or permanent remedial action.

2.5 If a risk to public safety has been identified at an initial stage of the assessment process by using simple methods, the findings should be immediately confirmed by another relatively quick method of assessment before reporting to the TAA. In choosing methods to complement the first simple method, those which involve grossly conservative simplifying assumptions should be avoided. Preference should be given to methods which recognise the participation of the complete structure in resisting collapse at the ULS (eg yield line analysis of slabs), and to methods which can model the restraints which may affect the response of a structural element (eg bending, torsional and in-plane restraints).

2.6 In general, for any structures which are considered to be inadequate, the assessing engineer should confirm any preliminary findings by a more accurate method or methods before making a final recommendation as to the appropriate remedial action for the structure in question.

2.7 When a potential risk to public safety is reported by the assessing engineer the TAA will advise the Director (Transport) accordingly. In the light of this and all the other relevant factors, the Director (Transport) will decide what, if any, immediate action needs to be taken to safeguard the public, both in the period while the full assessment procedures are being carried out and in the interim period before an inadequate structure can be replaced or strengthened. This decision will be taken after consultation, where necessary, with the Head of BE Division.

3. ASSESSMENT FOR HB OR OTHER ABNORMAL LOADING

3.1 Structures to be Assessed - BD 34/90 Clauses 1.3 and 5.4

Structures which can carry the 40 tonnes Assessment Live loading should be additionally assessed for the following categories of abnormal loading:

i. General: Type HB

ii. Specific: particular abnormal vehicle configurations

The first category shall apply to trunk road structures in the assessment programme for which an HB rating derived from recent design calculations is not available. The purpose is to determine the actual number of units of HB loading which the structure can carry. This 'HB rating' will be useful as a basis for checking for particular abnormal vehicles which may need to cross the structure from time to time. In addition the 'HB rating' would be used as a yardstick to indicate the relative load carrying capacity of any older structures which are retained following assessment. This data will be held on the Department's National Structures Data Base for future reference. Assessment of Highway Structures Form AHS/2i is to be used to enter the information (Questions 14 and 15 apply).

There is no need for any remedial measures even if the structure is found to be sub-standard with respect to the HB load requirement for new bridges on the route.

The second category of assessment is to be carried out only if it is known at the time of the assessment that a structure will be required to carry specific abnormal vehicles (eg when it is on a heavy load route) and that such an assessment has not already been carried out for that structure using current standards. The assessment should reflect any particular restrictions that are to be applied when the vehicle crosses the structure (eg the transverse disposition of the vehicle on the deck, or whether other traffic is allowed on the structure at the same time). Form AHS/2i Question 16 is to be used to indicate that the assessment has been carried out.

3.2 Load Combinations and Partial Factors - BD 21/84 Clause 7.1.

When loadings or load combinations other than those specified in Amendment No 1 to BD 21/84 are used for assessment purposes (HB loading falls into this category) these loadings are to comply with the requirements given in BD 37/88. (For further guidance see Section 8).

Type HB loading shall be used in conjunction with the 40 tonne Assessment Live Loading in place of the HA loading as appropriate. If for any reason this assessment is carried out with HB loading only on the deck, the Regional Office will take note of this fact with respect to future traffic management.

When specific abnormal loads are considered the load combinations for assessment should be derived by analogy with those for the assessment of HB capacity outlined above, but if a clear knowledge exists about planned future movements of these vehicles, it may be possible to utilise "full caution" provisions, or other conditions of such movements, to modify the load combinations which need to be considered. The Regional Office should take note of any assumptions with respect to future traffic management.

Where limit state methods of assessment apply, the appropriate ultimate limit state (ULS) partial factors from BD 21/84 or BD 37/88 should be applied to the nominal live loads. (For guidance on serviceability checks see Item 7).

4. ASSESSMENT OF SUBSTRUCTURES AND FOUNDATIONS

4.1 Analytical methods - Amendment No 1 to BD 21/84 Clause 4.1 and Section 10.

Substructures and foundations (columns and piers, for the purposes of BD 34/90, are to be considered part of the superstructure) are to be assessed using analytical methods when:

i. there are evident signs of distress or of corrosion or other forms of material deterioration, or,

ii. dead load is to be increased, for example by increased surfacing, or

iii. there is some doubt concerning sub-soil conditions or backfill pressures, for example when the quality or the extent of the backfilling is suspected to be grossly substandard, and deemed likely to cause problems in the short to medium term.

In addition it may be judged necessary to assess the substructures and foundations analytically if:

iv. The actual intensity of normal traffic loading which has been sustained by the structure is known to be substantially less than its full capacity, or,

v. the HB capacity of the superstructure (or capacity to carry specific abnormal loads) is substantially greater than the equivalent of the 40 tonnes Assessment Live loading. This will ensure that the HB rating discussed in 3.1 is realistic for both superstructures and substructures. (Please see C1 3.5.2d of Trunk Road Management and Maintenance Notice TRMM 2/88 with regard to special inspection procedures when structures are to carry abnormal heavy loads.)

4.2 Factors of Safety

When assessing substructures and foundations, factors of safety used for design may not be appropriate and relaxation from these should be considered, based on a realistic assessment of soil conditions etc. Such relaxations should be discussed and agreed with the TAA as departures from standards.

4.3 Structures in the Strengthening Programme

When a superstructure is to be strengthened or replaced the adequacy of the substructures and foundations should be checked as for any new design. Here again the factors of safety as given in CP2 and BS8002 may not be appropriate and appropriate relaxation should be considered in consultation with the TAA.

5. ASSESSMENT OF BEARINGS - EFFECTS ON SUBSTRUCTURES

If there are doubts concerning the freedom of movement and the general condition of bearings which were idealized as simple and/or sliding supports in the original design, the engineer should assess whether the present state, if different from the design condition, represents a long-standing status-quo. If so, and if the substructure or foundation show no signs of distress, then these may be assumed to be adequate, but measures to replace or free the bearings should be put in hand.

If, however, the loss of articulation may have occurred recently then, even in the absence of any sign of distress, an analytical check of the substructure which allows for the loss of articulation may be deemed necessary pending freeing or replacement of the bearings.

6. ASSESSMENT OF MULTI-SPAN MASONRY ARCHES

The MEXE method of assessment as given in BA 16/84 does not cover multi-span masonry arches but can be applied, pending further research, to such structures provided that the arch barrels fall within the scope of MEXE and the intermediate piers are capable of sustaining independently the thrust from either one of the adjoining spans ie when the intermediate piers are of stocky construction. Where intermediate piers are slender there will be structural interaction between the spans and some other form of analysis will have to be applied.

The use of the MEXE method for assessing multi-span masonry arches should be treated as a departure from standard.

7. SERVICEABILITY CHECKS

7.1 General

BD 21/84 Clause 5.2.1.

Serviceability criteria are given in the design standards which are used in conjunction with BD 21/84. Failure to satisfy S.L.S checks will not normally be a cause for remedial action in the shorter term. Management of the structure may however be affected, eg. by increased frequency of inspection or specific inspection to seek possible faults suggested by the particular type of S.L.S failure. Remedial action may in due course become necessary.

7.2 Cracking in Concrete

Crack widths in reinforced concrete should be compared to the values given in Table 1 of BS 5400: Part 4 when checked in accordance with C1 4.2.2 of Part 4.

In limiting cracking in prestressed concrete, Class 1 category shall apply for assessment. However, where centrifugal loading is included in the assessment, it is considered that a Class 2 Category should be permitted.

8. OTHER LOADS

BD 21/84 Clause 7.1

8.1 The following should apply when loads other than those specified in BD 21/84 are considered necessary for assessment:

i Global effects of temperature should be considered if the structural form warrants it, eg for portals or decks with fixed supports; the effects of differential temperature can generally be ignored.

ii Earth pressure effects should always be considered where applicable.

iii Creep and shrinkage effects should be considered.

iv Wind Loading should be considered only for lightweight structures and for major structures where it effects are likely to be significant (eg extremely exposed structures).

v Differential settlement effects can generally be ignored, except where significant settlement has been found during inspection, and where the effects of such settlement are likely to be important for the assessment.

9. ACCIDENTAL WHEEL LOAD

BD 21/84 Clause 7.5.

The configuration of the accidental wheel load (Table 7.3A) is to be used for assessing 'local' strengths of elements such as cantilever slabs supporting footways etc. When longitudinal members are located entirely under footways or central reserves, the single wheel or the single axle load, placed on the footway or the central reserve as applicable is to be used for their assessment.

10. MAXIMUM GROSS VEHICLE WEIGHT

The 40 tonne Assessment Live Loading curve covers the effects of the 44 tonne EC vehicles allowed under Directives 85/3/EEC and 86/360/EEC. These vehicles of 44 tonnes gross weight will be used for the movement of 40 foot ISO containers in combined rail/road transport operations and as such will have the maximum length for articulated vehicles of 15.5m. The 40 tonne EC vehicles can be shorter and therefore can produce higher loading effects.

11. REFERENCES

1. BD 34/90 - Technical Requirements for the Assessment and Strengthening Programme for Highway Structures Stage 1 - Older Short Span Bridges and Retaining Structures: DTp: 1990.

2. BD 21/84 and BA 16/84 - The Assessment of Highway Bridges and Structures: DTp 1984 and Amendment No 1: DTp: 1989.

3. BD 37/88 - Loads for Highway Structures: DTp: 1989.

4. BS 5400: Part 4 - Steel, Concrete and Composite Bridges. (As implemented by Departmental Standards).

12. ENQUIRIES

Technical enquiries arising from the application of this Advice Note to a particular structure should be addressed to the Technical Approval Authority for that scheme.

All other enquiries or comments about this Departmental Standard should be sent in writing to:

Head of Division
Bridges Engineering Division
Department of Transport
St Christopher House
Southwark Street
LONDON
SE1 0TE

Quoting reference:
BE 21/16/014

Orders for further copies of this Departmental Standard should be accompanied by the remittance shown on the cover and addressed to:

DOE/DTp Publications Sales Unit
Building One
Victoria Road
South Ruislip
Middlesex HA4 0NZ

Telephone No: 01- 841 3425